U.S. Department of Energy's

Office of Science

SciDAC, FSP & High Performance Computing Updates

FY 2009 OFES Budget Planning Meeting

Office of Fusion Energy Sciences
Excellent Science Attractive Energy

www.ofes.fusion.doe.gov

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OFES
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Outline

- Status of FES SciDAC Projects
- Status of the Fusion Simulation Project (FSP)
- OFES HPC Resources—an overview
  - NERSC
  - INCITE

Status of FES Scientific Discovery through Advanced Computing (SciDAC) Projects

	FY 2006	FY 2007 (CONG)	FY 2008 (CONG)
Funding ($ Millions)	4.2	6.9	7.2

- Supports multi-institutional teams of plasma physicists, applied mathematicians and computer scientists working together to achieve scientific advances through computer simulations
- The FES SciDAC projects have been very successful in taking advantage of today's leadership class terascale computing facilities to develop high-performance computational tools that have provided us with new and significant insights into questions of fundamental importance in fusion plasma science.
- Currently, there are six projects in the OFES SciDAC portfolio: three original SciDAC projects focused on topical science areas, and three Fusion Simulation Prototype Centers focused on code integration

OFES SciDAC Projects

Gyrokinetic Particle Simulation Center (GPSC)

- Turbulent transport in burning plasmas using PIC codes
- PI: W.W. Lee (PPPL)
- PPPL, UC Irvine, ORNL, U Colorado, UCLA, U Tennessee, UC Davis, Columbia U

Center for Extended Magnetohydrodynamic Modeling (CEMM)

- Macroscopic stability and nonlinear dynamics using 3D extended MHD codes (M3D & NIMROD)
- PI: S. Jardin (PPPL)
- PPPL, U Wisconsin, Tech-X, MIT, NYU, U Colorado, U Utah, Utah State U

Center for Simulation of Wave-Plasma Interactions (CSWPI)

- Launching, propagation and absorption of high power EM waves and RF-driven modifications to the background plasma distribution function (TORIC, AORSA, CQL3D)
- PI: P. Bonoli (MIT)
- MIT, ORNL, CompX, Lodestar, General Atomics, Tech-X, PPPL

Fusion Simulation Prototype Centers

Center for Simulation of Wave Interactions with MHD (SWIM)

- Brings together state of the art extended MHD and RF codes to investigate the interactions of waves with MHD and the mitigation of instabilities
- Develop Integrated Plasma Simulator (IPS) – framework to allow coupling of virtually any fusion code, not just RF and MHD
- PI: D. Batchelor, ORNL
- ORNL. Indiana U, Columbia U, General Atomics, CompX, U Wisconsin, MIT, NYU, LBNL, Lehigh U, Tech-X

Center for Plasma Edge Simulation (CPES)

- Develop integrated predictive plasma edge simulation package applicable to burning plasma experiments; integrates edge gyrokinetics with extended MHD codes
- PI: C-S Chang (NYU)
- Caltech, Columbia U, LBNL, Lehigh U, MIT, ORNL, PPPL, Rutgers, UC Irvine, U Colorado, U Tennessee, U Utah

Framework Application for Core-Edge Transport Simulations (FACETS)

- Multi-physics, parallel framework application for full-scale fusion reactor modeling; initial focus is core to wall transport modeling
- PI: J.R. Cary (Tech-X Corp)
- Tech-X, LLNL, PPPL, ANL, UCSD, CSU, ORNL, ParaTools, GA, Columbia U, LBNL, Indiana U, MIT, NYU, Lodestar
- Associated SAP: Steady State Gyrokinetic Transport Code, PIs: M. Fahey (ORNL), J. Candy (GA)

OFES SciDAC Projects
2007 Recompetition

- **The first three SciDAC projects (GPSC, CEMM, & CSWPI) are up for recompetition in 2007**
- **Four SciDAC notices have been posted on our Grants and Contracts Website and on Grants.gov:**

Notice	Area of Interest	LOI due date	Proposal due date
07-19	RF Waves in Plasmas	4/03/07	5/15/07
07-20	MHD	4/10/07	5/22/07
07-21	Turbulence & Transport	4/17/07	5/29/07
07-22	Energetic Particles	4/23/07	6/04/07

The Fusion Simulation Project (FSP)

- A new computational initiative—jointly supported by OFES and OASCR—aimed at the development of a whole-device predictive simulation capability for toroidal fusion devices focused on ITER, but also relevant to major current and planned toroidal fusion experiments
- Driven by the ITER needs; it will also make the U.S. the world leader in fusion plasma simulations and maximize the benefit from our participation in ITER
- The feasibility and timeliness of the FSP initiative is supported by recent advances in computer software and hardware: success of our SciDAC projects and emerging availability of petascale resources
- An FSP workshop—co-chaired by Prof. Arnold Kritz and Prof. David Keyes—is planned for May 2007, to develop a detailed roadmap with major scientific and computational milestones
- Workshop Website: **http://www.lehigh.edu/~infusion/**

OFES High Performance Computing Resources

2007 Allocation Year (AY)

NERSC (*Seaborg, Bassi, Jacquard*)

- **51 FES repositories**
  - **7 SciDAC**
  - **1 INCITE**
- **OFES AY 07 allocation: 16.7M hours**
  - **29% of SC resources**
- **AY 07 request by FES PIs: 41.3M hours**
- **Additional resources should become available later this year with the addition of the 100+ teraflop NERSC-5 (CRAY XT4, *franklin*)**

2007 INCITE Program

- The Innovative and Novel Computational Impact on Theory and Experiment (INCITE) program provides resources to large scale computationally intensive projects that can make high-impact scientific advances
- Now in its fourth year, INCITE has expanded to include 80% of the leadership class computers at ORNL, and smaller percentages from other centers (10% NERSC; 10% ANL; 5% PNNL)
- Seven FES projects were selected for INCITE awards in AY2007, following a peer review
- SciDAC PIs are strongly encouraged to apply for INCITE resources

FES INCITE Projects—New

Gyrokinetic Steady State Transport Simulations

- PI: J. Candy (GA)
- Cray XT3 (ORNL), 1M hours
- SciDAC: FACETS

High Power Electromagnetic Wave Heating in the ITER Burning Plasma

- PI: F. Jaeger (ORNL)
- Cray XT3 (ORNL), 0.5M hours
- SciDAC: CSWPI

Three-Dimensional Particle-in-Cell Simulations for Fast Ignition

- PI: C. Ren (U Rochester)
- NERSC (LBNL), 2M hours
- Fusion Science Center for Extreme States of Matter

FES INCITE Projects—Renewals

Simulation of Wave-Plasma Interaction and Extended MHD in Fusion Systems

- PI: D. Batchelor (ORNL)
- Cray XT3 (ORNL), 2M hours
- SciDAC: SWIM

Gyrokinetic Plasma Simulation

- PI: W.W. Lee (PPPL)
- Cray XT3 (ORNL), 6M hours; Cray X1E (ORNL), 75K hours
- SciDAC: GPSC, CPES

Computational Atomic and Molecular Physics for Advances in Astrophysics, Chemical Sciences and Fusion Energy Sciences

- PI: M. Pindzola (Auburn U)
- Cray X1E (ORNL), 750K hours
- SciDAC: -

Interaction of ITG/TEM and ETG Gyrokinetic Turbulence

- PI: R. Waltz (GA)
- Cray X1E (ORNL), 500K hours
- SciDAC: -